

S&A FY03 ANNUAL REVIEW MEETING

Remote Automatic Material On-line Sensor

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Project Overview

- **Project description**

- Low field magnetic resonance (optionally single sided) is used to perform continuous, remote measurements on industrial materials

- **Objectives**

- Moisture content of wood/wood chips to $\pm 0.5\%$
- Moisture content of coal to $\pm 0.25\%$
- Rapid measurement of hydrogen content in CaO

- **Overall goal**

- Provide rapidly updated material property measurements with required accuracy and affordable price

Technical Merit

- **Addresses technical need(s) of the S/C community and the S/C priorities of the IOFs**
 - Moisture content measurement for Forest Products
 - Moisture content measurement for Mining
 - Hydrogen content measurement for Steel

Technical Merit

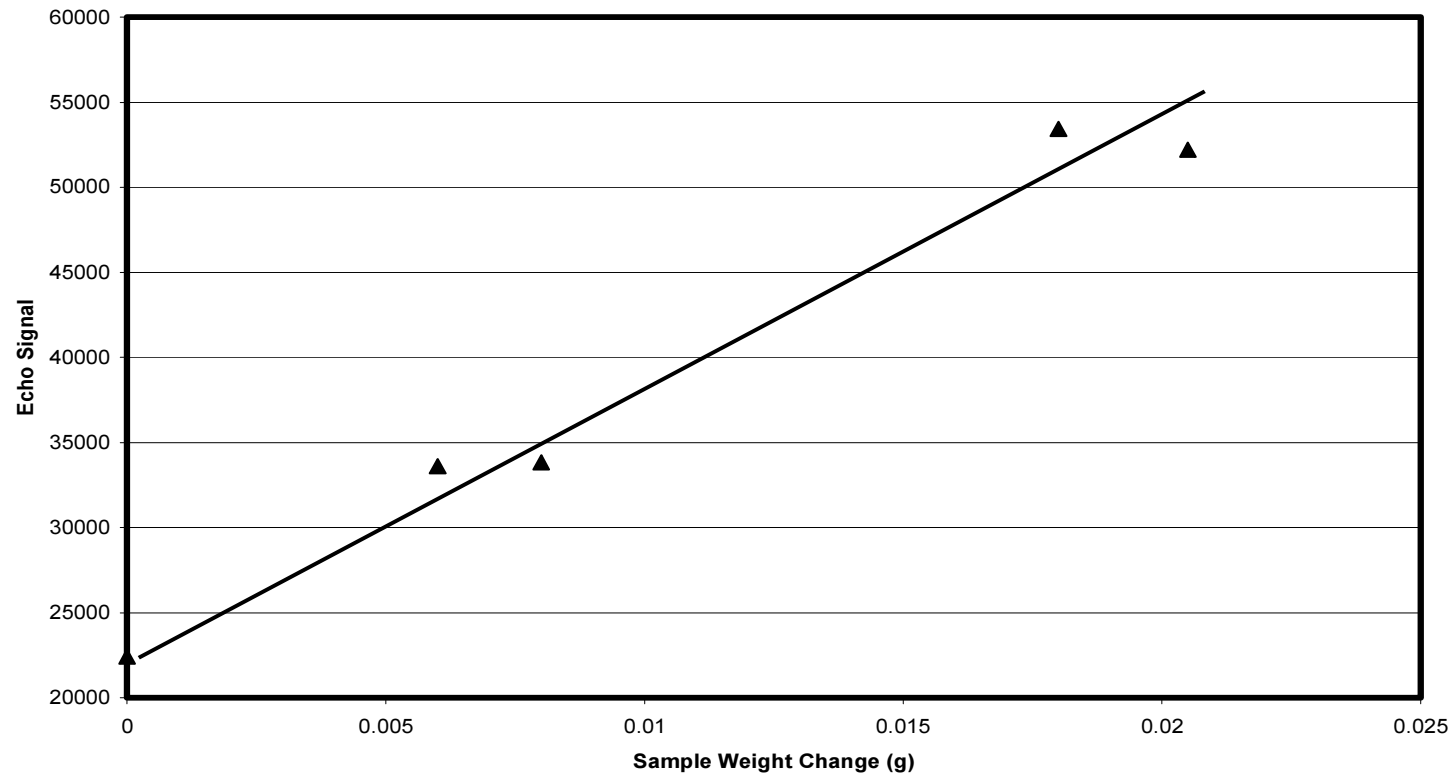
- **Contributes new information or technology to the S/C community**
 - Provides accurate moisture content measurements when MC>30%
 - Use UCB/LBNL developed techniques to discriminate wood fiber/ice and wood moisture/rain water
 - Provides fast, clean and non-destructive measurement of hydrogen content in CaO

Technical Progress and Outlook

- **Magnet completed**
 - Met design specifications for field strength and homogeneity
- **RF probe completed**
 - Installed in enclosure
 - NMR measurement performed
- **Computer and electronics acquired and assembled**
- **RF power amplifier components acquired**
- **Demonstrated ability to measure hydrogen content in CaO (quicklime)**

Hydrogen content of Quicklime

HYDROGEN IN CALCIUM OXIDE
Signal vs Water Addition. Average of two samples.



Correlation between sample weight change and signal amplitude. Although high precision has not yet been demonstrated, due to experimental limitations, the results indicate a good correlation between absorbed water and signal, thus demonstrating that the hydrogen in quicklime may be measured by magnetic resonance. The observed amplitude corresponds to 80% of the signal expected from pure water.

Technical Progress and Outlook

Future Technical Milestones/Goals

Milestone/Goal	Expected Completion Date	Comments
Integrate new QM preamplifier	June 2003	Performance gain worth waiting for
Final in house testing	Early July 2003	
Beta test at Paprican (Vancouver BC)	July 2003	
CaO beta test	??	
Project Completion	October 2003	

Technical Progress and Outlook

- **Integrate new QM pre-amplifier**

- Being developed for landmine detection program
- Very low noise (noise temp $\approx 20\text{K}$) leading to factor of 3 to 4 improvement in signal to noise ratio
- Designed to greatly improve transient recovery time
- Risk is that pre-amplifier may not achieve desired recovery time (≈ 15 microseconds)

- **Final in house testing**

- Verify system works as expected
 - Shouldn't require "hand holding" by QM personnel
- Final integration of control and analysis software
 - Software for prototype will emphasize flexibility

Technical Progress and Outlook

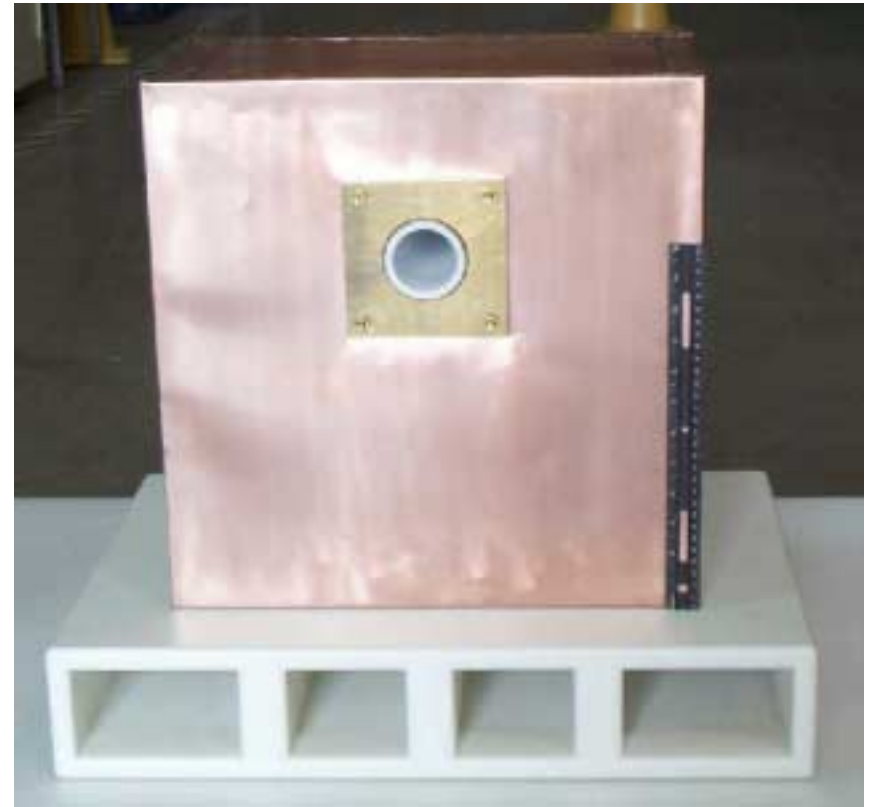
- **Beta test at Paprican**

- Initial emphasis on wood moisture measurement
- Will investigate other applications in pulp and paper mills
 - e.g. Black Liquor (follow-on to SwRI and UCB/LBNL)

- **CaO beta test**

- More work needs to be done on validating NMR measurements
- Have not found beta test site yet.

Magnet and magnet enclosure



Left: Bare magnet with simulated probe (windings are for temperature compensation)

Right: Magnet and probe enclosure

Technical Progress and Outlook

- **Industrial end-user involvement**

- Working with Paprican on system testing
 - They have facilities for validating sensor performance
 - Would not involve disruption of production
 - Would provide IP for process control
- Have held discussions with AMEC for integration with pulp mills
 - Have extensive experience in mill design and construction
- Looking for partner for CaO

Market Potential

■ Commercialization plan

- QM intends to be OEM supplier of MR hardware
 - System engineering to reduce cost of production (some task shared with other QM programs)
 - System engineering for integration with plant control systems (primarily a software task)
- Work with Paprican, AMEC, etc to identify early adopters of technology for pulp and paper mills
- Identify opportunities in paper recycling industry (e.g. assuring fiber content)
- Work with early adopters in hardwood lumber industry
 - Interest better monitoring of drying process and some interest in fiber density

Market Potential

- Work with engineered lumber
 - Wood is typically over-dried to prevent blowouts when heating and that reduces pliability of the wood fibers
- **Other IOF areas of applicability**
 - Moisture content measurement of ore
 - Discussions held with UCB/LBNL
 - Hydrogen content of raw material for steel and glass
 - CaO for steel and glass
 - Coke for steel
 - Measure properties of petroleum
 - May be useful to determine end of well life

Market Potential

- **After OIT project completion, what's next?**
 - Aviation Security market is maturing, renewing InVision's interest in other markets
 - Potential collaboration with UCB/LBNL on ore measurements
 - Application of technology developed under this program
- **Market potential (optimistically assuming market saturation)**
 - Paper and pulp: 1,000 units
 - Engineered lumber: 100 units
 - Lumber: 200 units
 - Steel: 100 units

Programmatic Merit

- **Energy benefits**

- Assuming approximately 0.2% improvement in energy efficiency of Paper and Pulp mills: 10^{12} BTU
- Potential of 75,000,000 KWH/yr in lumber industry from improved kiln operation
- Energy benefits for Steel industry have not been quantified

Programmatic Merit

- **Economic and environmental benefits**
 - Reduced cost of operation of paper and pulp mills due to decreased energy consumption, reduced chemical consumption and increase in yield
 - Estimated \$10,000,000/year for hardwood lumber industry from decreased electricity consumption and reduced wood damage

Summary

- **System should be ready for beta testing in early July**
 - Goal of beta testing is to demonstrate (ideally) improved performance of MR versus current moisture measurement technology
 - An additional goal is to identify other suitable locations in mill for use of the instrument
- **Looking for beta test site for Hydrogen in CaO**
- **Improved pre-amplifier design should significantly decrease measurement time to achieve desired accuracy**